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How Quickly do Bromeliads Decay?

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ABSTRACT

Leaf decay and toughness of two Florida bromeliads were compared with other common vegetation found growing in close proximity. Species included: live oak *(Quercus virginiana),* passionflower vine *(Passiflora incarnata),* citrus *(Citrus sinensis),* ball moss *(Tillandsia recurvata),* Spanish moss *(Tillandsia usneoides),* and butterfly orchid *(Encyclia tampensis).* The bromeliad foliage was moderately tough, with leaves ranked (in order of decreasing toughness): orchid, live oak, ball moss, citrus, Spanish moss, and passionflower. The softest leaves (passion vine) decayed most quickly, while the toughest leaves were the slowest to decay. The epiphytes experienced a short growth burst during their duration on the forest floor, so their pattern of decay was not a linear decline as were the vines and trees.

INTRODUCTION

Decay is an important process in ecosystems, because it facilitates nutrient cycling and serves as an important regulator of the maintenance of species (reviewed in Coleman and Crossley 1996). In Florida and elsewhere, epiphytes compose a relatively large portion of the aboveground vegetation in many regions, especially forest hammocks (Lowman and Nadkarni 1995). As a result, epiphyte decay is important to the nutrient cycling of Florida hammock ecosystems. Their rates of foliage decay and associated foliage toughness, have never been measured or compared to other plants that grow in the same habitat

Benzing (1990) suggested that bromeliads suffer negligible herbivory, so we might assume that their foliage is extremely tough or toxic. Studies in tropical rain forests have shown that some bromeliads, despite high levels of leaf toughness, do suffer moderate levels of insect damage (Lowman *et al* 1996), but this is the only study to date that has measured herbivory in bromeliads of forest canopies with quantitative techniques.

In this study, we measured the toughness and decay of two common Florida bromeliads, and compared them to four other plant species that grow in association: two phorophytes, one vine and one epiphytic orchid. Our hypotheses were; 1. that bromeliad foliage would be tougher than other species, thereby rendering them relatively resistant to insect attack and also to decay; 2. and that plants with softer leaves would decay more quickly than those with tougher leaves.

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METHODS

Two common Florida bromeliads were selected for study: Spanish moss *(Tillandsia usneoides)* and ball moss *(T. recurvata),* both of which inhabit tree canopies in both natural hammocks and urban trees. Four plants were selected for comparisons that grow in association with these bromeliads: two phorophytes (Orange trees, *Citrus sinensis;* and live oak, *Quercus virginiana),* one vine (passionflower vine, *Passiflora incarnata)* and one epiphytic orchid *(Encyclia tampensis).*

For the leaf decay measurements, nineteen mesh fruit bags were obtained from Albritton Fruit Company. The bags measured 29 cm x 14.5 cm with a mesh of 6 mm x 4 mm. Three leaf samples, each composed of 20 gm fresh weight foliage, were obtained for all six species, and placed in a separate mesh bag. The bags were labeled and placed on the ground under a live oak canopy (see Figure 22). Bags were laid flat and staked to the ground so that wind and animals could not dislodge them. The bags were weighed every two weeks for six months, and then monthly for 8 months, until the majority of the leaves had disappeared after approximately one year. A control bag was also placed on the forest floor and weighed, to insure that the bag weights were not affecting the results. These methods had proven successful in previous field studies (Lowman 1988).

Leaf toughness was measured with a penetrometer, made from Plexiglass sleeves and a metal rod that penetrated the leaf surface with a known volume of water (Lowman and Box 1983) (see Figure 23). Three measurements on each of three fresh leaves of the six species were measured for toughness values. Toughness was expressed in g (water weight required to puncture).

RESULTS AND DISCUSSION

The penetrometer readings showed that the orchid was the toughest leaf, with almost 8000 g water weight required to puncture the foliage. In contrast, passion vine was extremely soft with only 528 g water weight required to puncture the leaf. From softest to toughest, the rankings were: passion vine, Spanish moss, citrus, ball moss, live oak, and orchid (Table 1). Statistical analyses showed that ball moss and citrus had similar toughness values, but that all other species were significantly different (t-test: $F = 324.67$, $p > 0.0001$; SNK grouping: orchid > live oak > ball moss and citrus > Spanish moss > passion vine).

The decay rates reflected the toughness values, with the passion vine leaves disappearing in two months. In contrast, the Spanish moss, ball moss, orchid and live oak foliage exhibited less than 50% decay after four months, and had approximately 25% remaining after one year (Figure 24). Both bromeliads experienced anomalies in their decay after several months. Instead of a smooth declining curve like the other four species, they actually underwent an apparent increase in foliage weight! This aberration is probably a consequence of their

Figure 22.
Mesh bags containing known weights of foliage were laid on the forest floor to monitor decay rates.

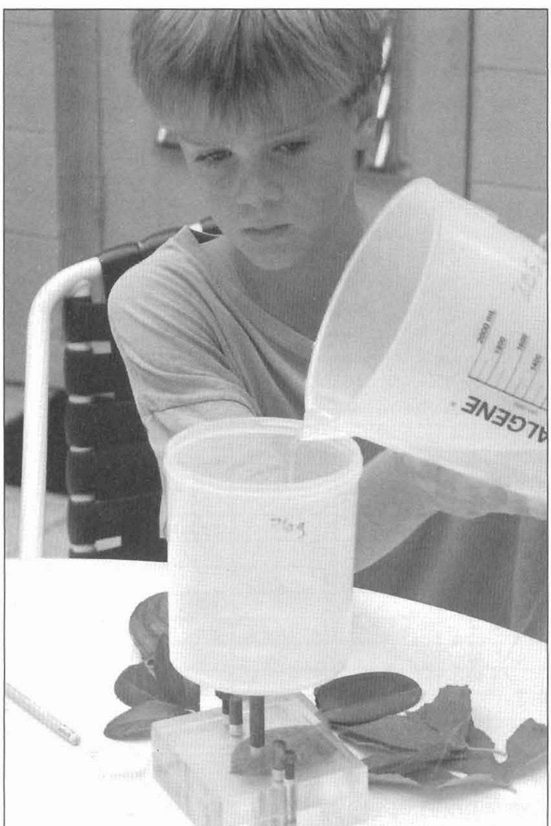

Figure 23.
A penetrometer was used to estimate leaf toughness.

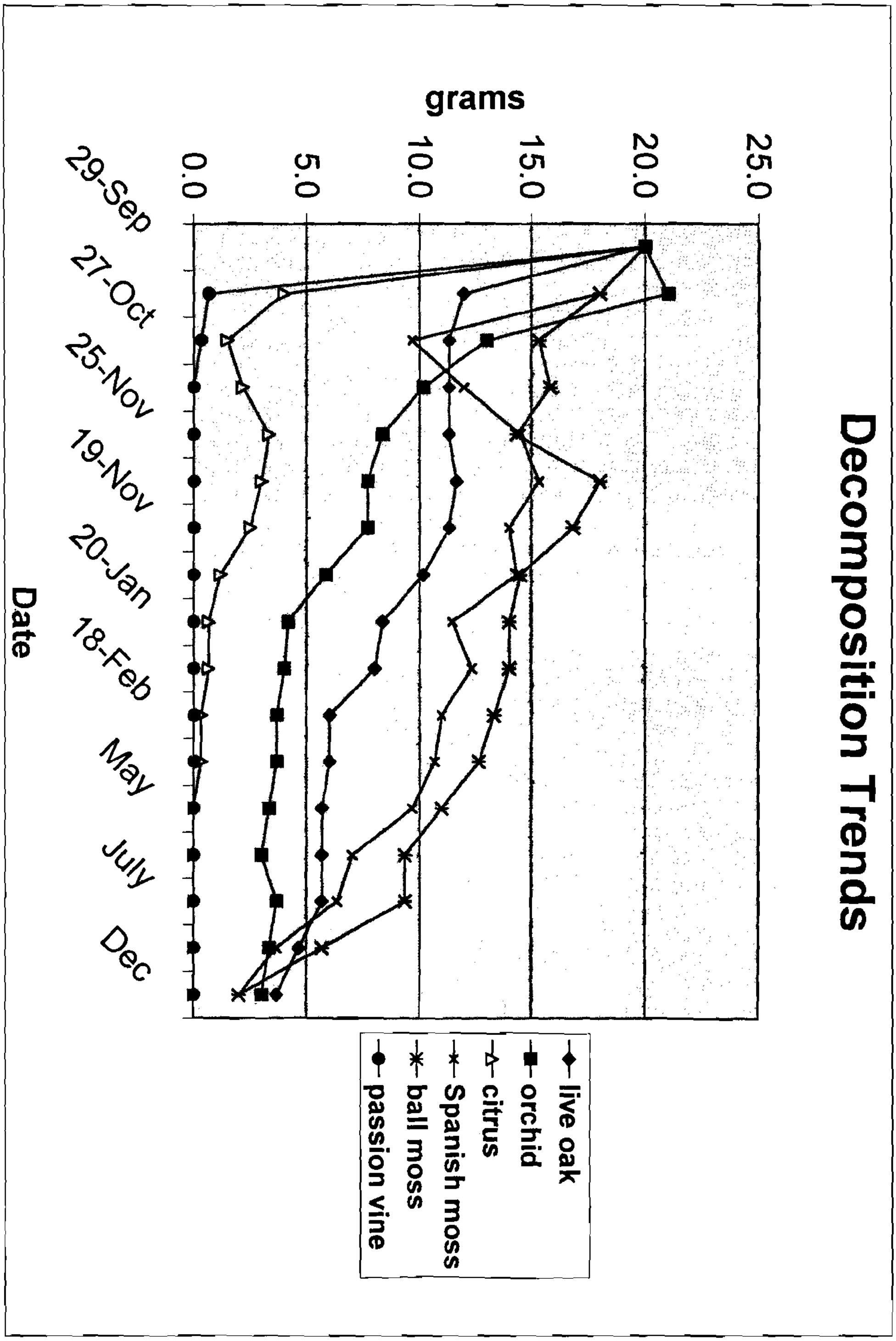

Figure 24

The decomposition trends for some Florida epiphytes and associated plants

Penetrometer Data					
species	leaf#	hole#	reading (g)	species average (g)	leaf average (g)
passion flower	1	1	465	528	510
		2	539		
		3	527		
	2	1	533		534
		2	517		
		3	551		
	3	1	569		541
		2	531		
		3	523		
citrus	1	1	1849	1952	2045
		2	1716		
		3	2569		
	2	1	1957		1897
		2	1862		
		3	1872		
	3	1	1987		1916
		2	1798		
		3	1962		
live oak	1	1	5851	5210	5711
		2	5439		
		3	5844		
	2	1	5186		4772
		2	4445		
		3	4684		
	3	1	5960		5147
		2	4669		
		3	4811		
orchid	1	1	7847	7881	8431
		2	9000		
		3	8445		
	2	1	7445		8182
		2	8655		
		3	8445		
	3	1	7445		7031
		2	7509		
		3	6138		
ball moss	1	1	2320	2288	2443
		2	2390		
		3	2620		
	2	1	2220		1992
		2	1985		
		3	1770		
	3	1	2997		2430
		2	2220		
		3	2073		
Spanish moss	1	1	1295	1365	1331
		2	1300		
		3	1399		
	2	1	1356		1383
		2	1358		
		3	1435		
	3	1	1395		1381
		2	1385		
		3	1362		

Table 1

Leaf toughness for some Florida epiphytes and associated plants.

epiphytic behavior, whereby these plants actually grew slightly when placed upon the ground instead of desiccating and undergoing immediate decay as with the leaves of trees and vines. Or perhaps bromeliads, by virtue of their tank structure, retain water for many months after falling from a host tree and survive on the forest floor without immediate death and decay.

The relatively slow decay of bromeliads has important consequences for the ecosystem. Rather than re-cycling nutrients back into the soil immediately upon displacement from the tree, Florida bromeliads appear to remain structurally intact for several months. This means that they do not contribute rapid mobilization of nutrients back into the ecosystem, but a slow trickle of nutrient material. In contrast, the citrus and passion vine foliage contribute their entire biomass with stored nutrients back into the soil within several months after senescence. Both slow and rapid nutrient re-cycling may be beneficial to the overall nutrient balance of a forest ecosystem, because together they may insure the long-term homogeneity of nutrient influx into the system.

Although none of the bromeliads ultimately survived on the forest floor, their relatively tough leaves and unique epiphytic habit facilitated slow decay. Further studies of decay rates of bromeliads in tropical systems would expand our understanding of the role that these epiphytes play in forest nutrient cycling. We speculate that epiphytes are not only important to catching nutrient pools in their tanks and enhancing biodiversity in the canopy, but they also regulate the cycling of nutrients back to the forest floor and in this fashion contribute to the biodiversity of soil organisms.

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